Virtual Prototyping with SPEED

Peter Mantica, Chris Lietzke, Jeramiah Zimmermann, Charlie Woodhouse, Dennis Jones

ITT Industries

Advanced Engineering and Sciences Division

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
01 OCT 2005	**N/A**	**-**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Virtual Prototyping with SPEED	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **ITT Industries Advanced Engineering and Sciences Division**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES
See also ADM001851, Proceedings of the 2003 Joint Service Scientific Conference on Chemical & Biological Defense Research, 17-20 November 2003. , The original document contains color images.

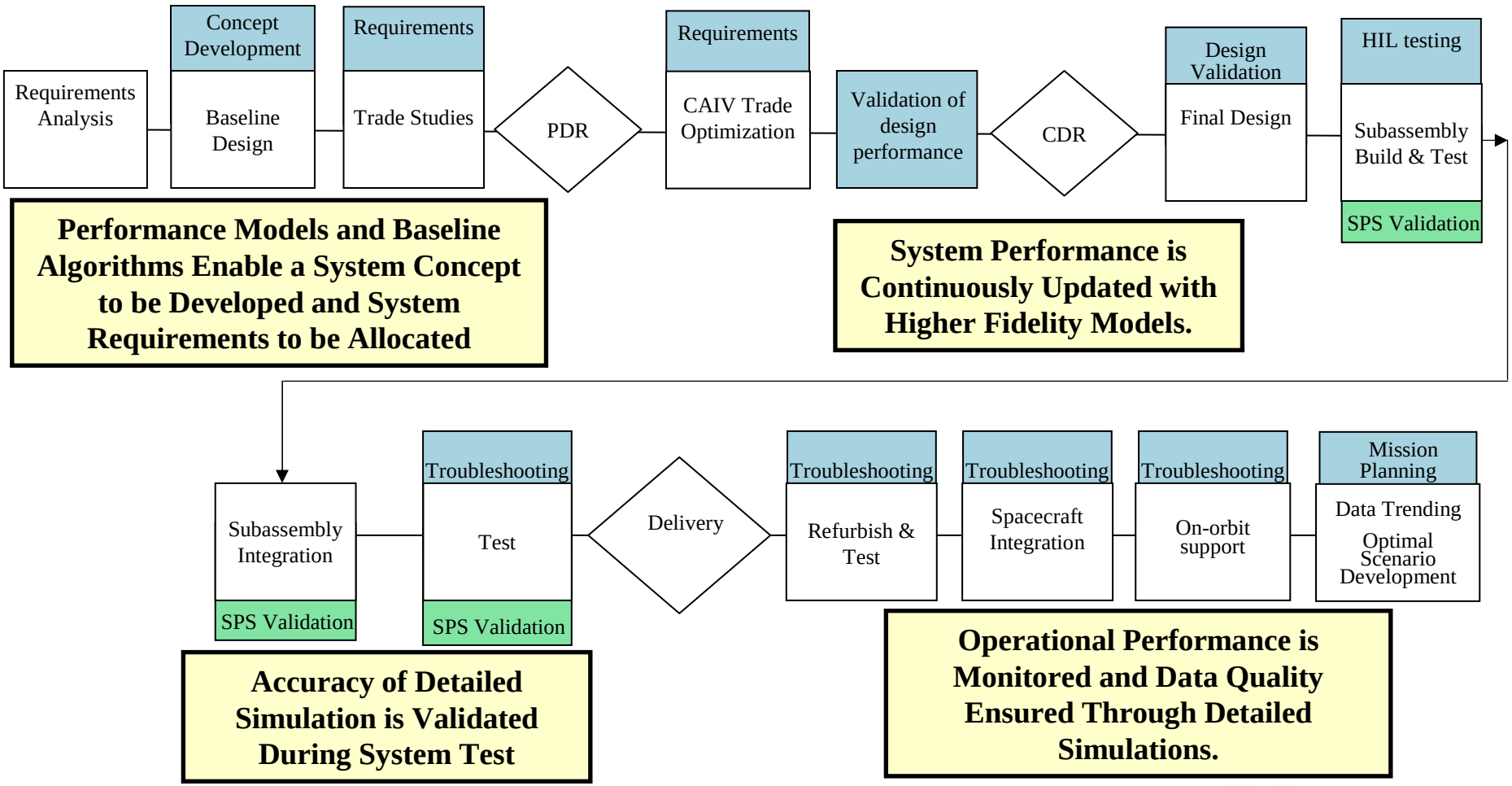
14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**UU**	**18**	

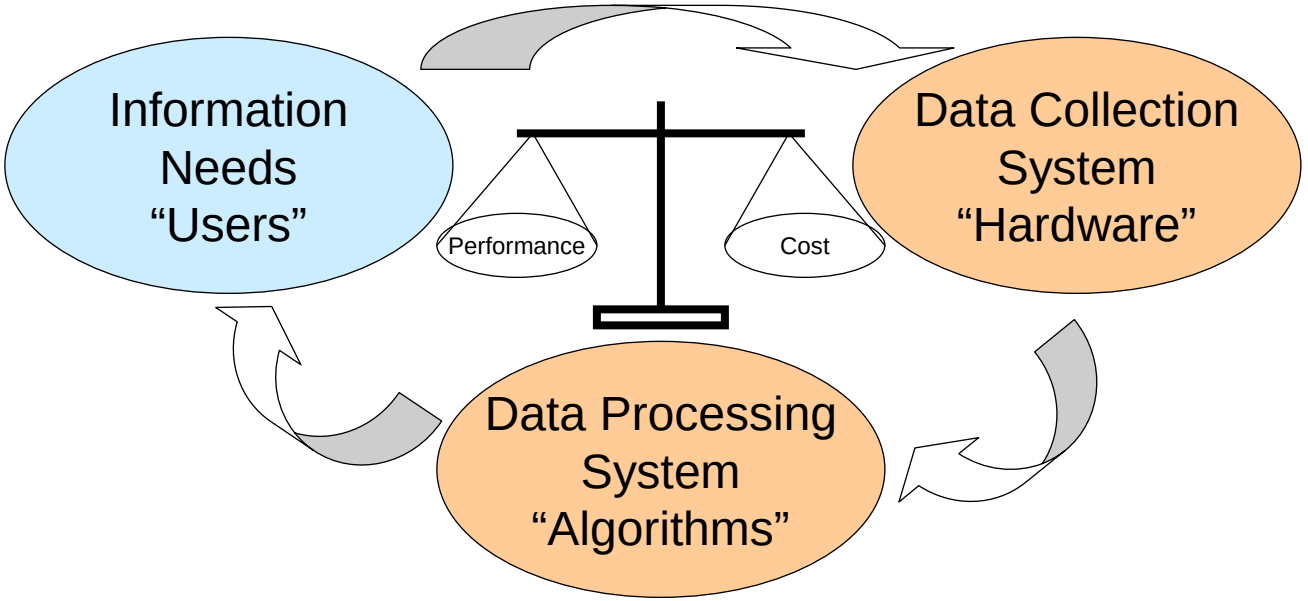
Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

A Virtual Prototyping System Supports All Phases of the Product Development Cycle



ITT Industries
Engineered for life
Advanced Engineering & Sciences

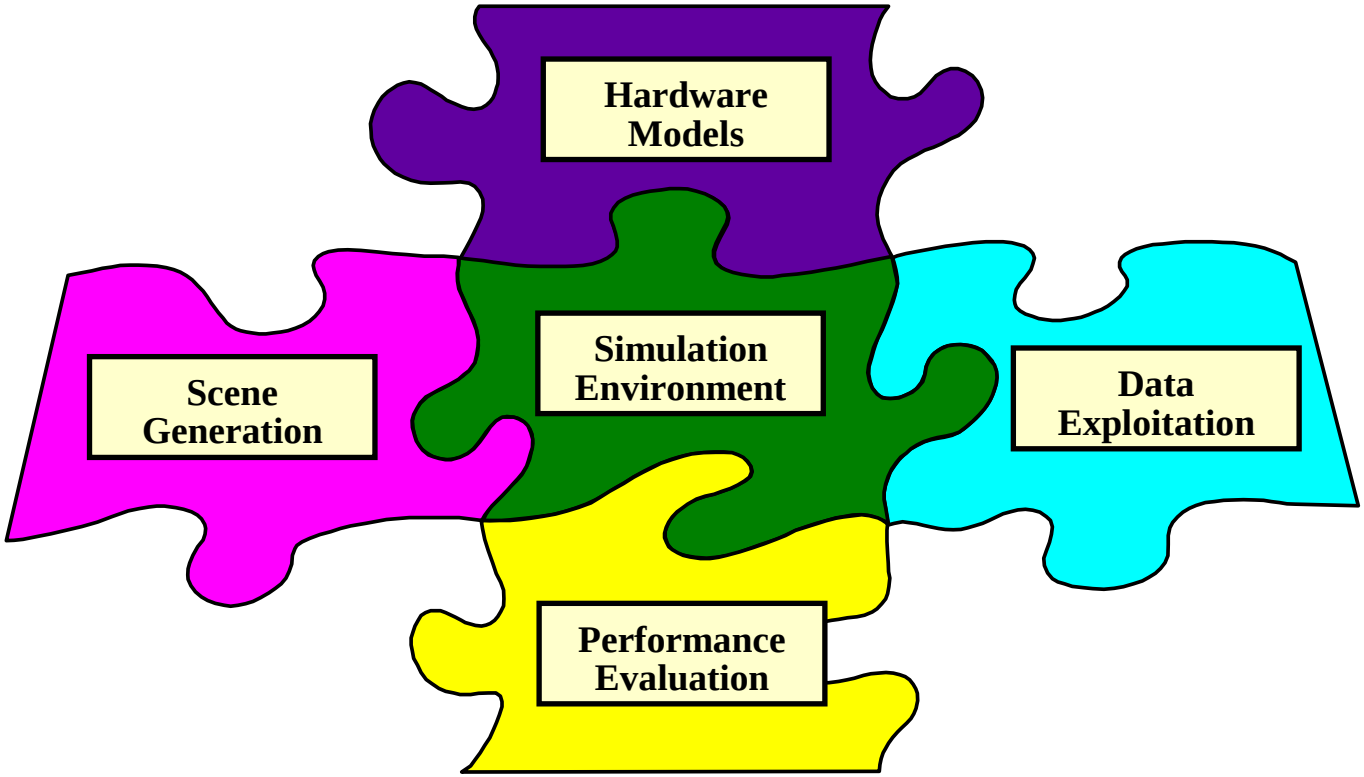
Integration of Hardware Models and Algorithms within a Virtual Prototyping System Enables Optimal System Development



Effective Development and Use of an Integrated System Performance Testbed is the Only Method to Ensure Optimal System Development

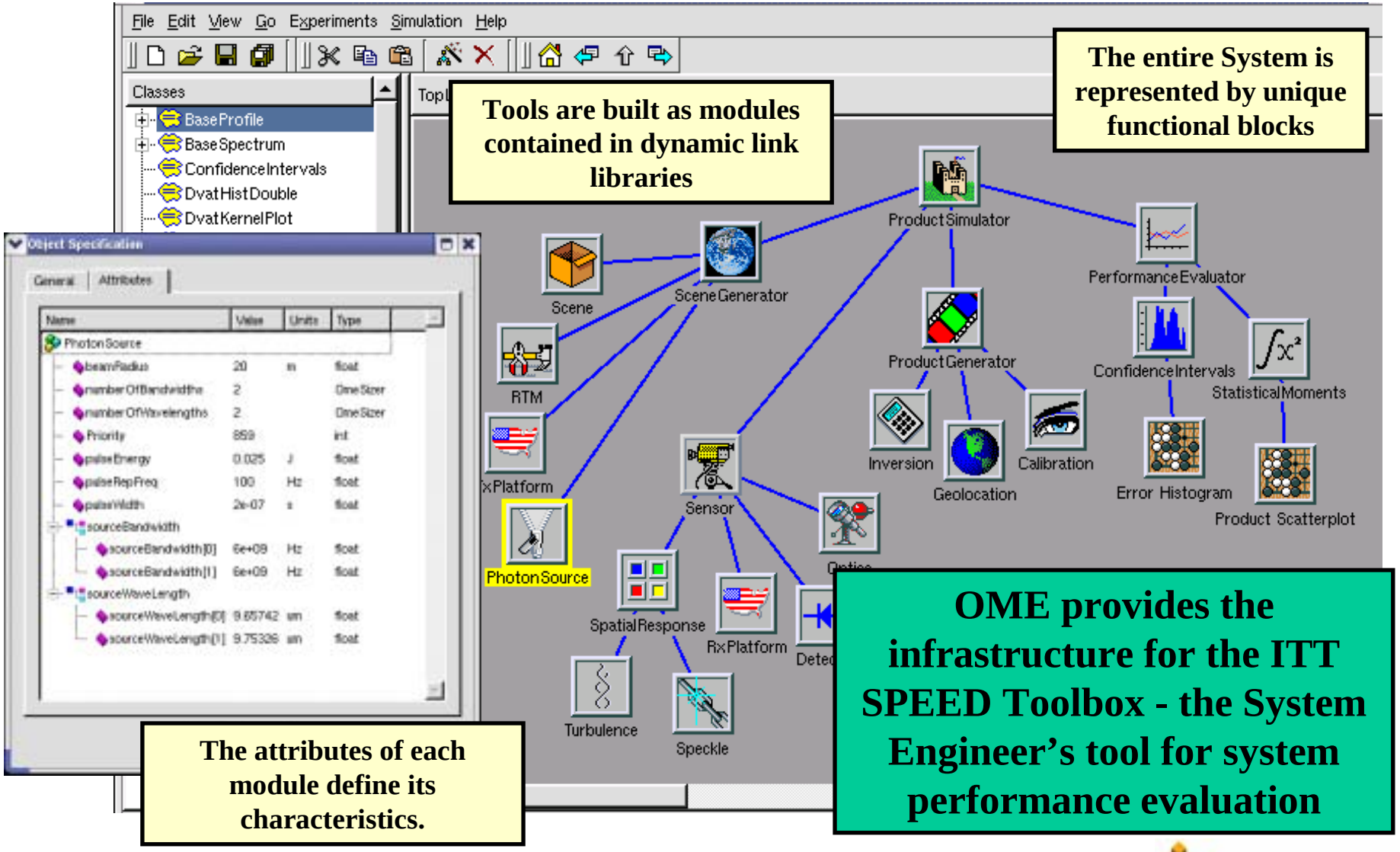
- Enables Information Product Driven Development
- Facilitates Early Selection of Optimal Approach
- Facilitates in Quickly Lowering Program Risk and Cost

SPEED: A Virtual Prototyping System Consisting of Four Capabilities Integrated into a System Environment



Each Capability Must be Addressed and Understood To Allow the Complete Evaluation of the End-to-End Performance of a Sensing System

The Object Management Environment is the Foundation of a Seamless Simulation

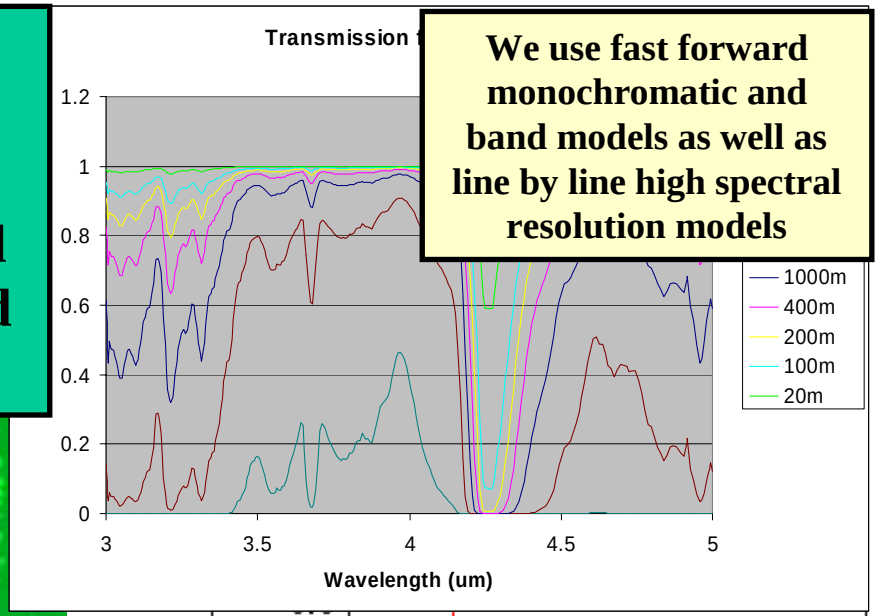


ITT Industries
Engineered for life
Advanced Engineering & Sciences

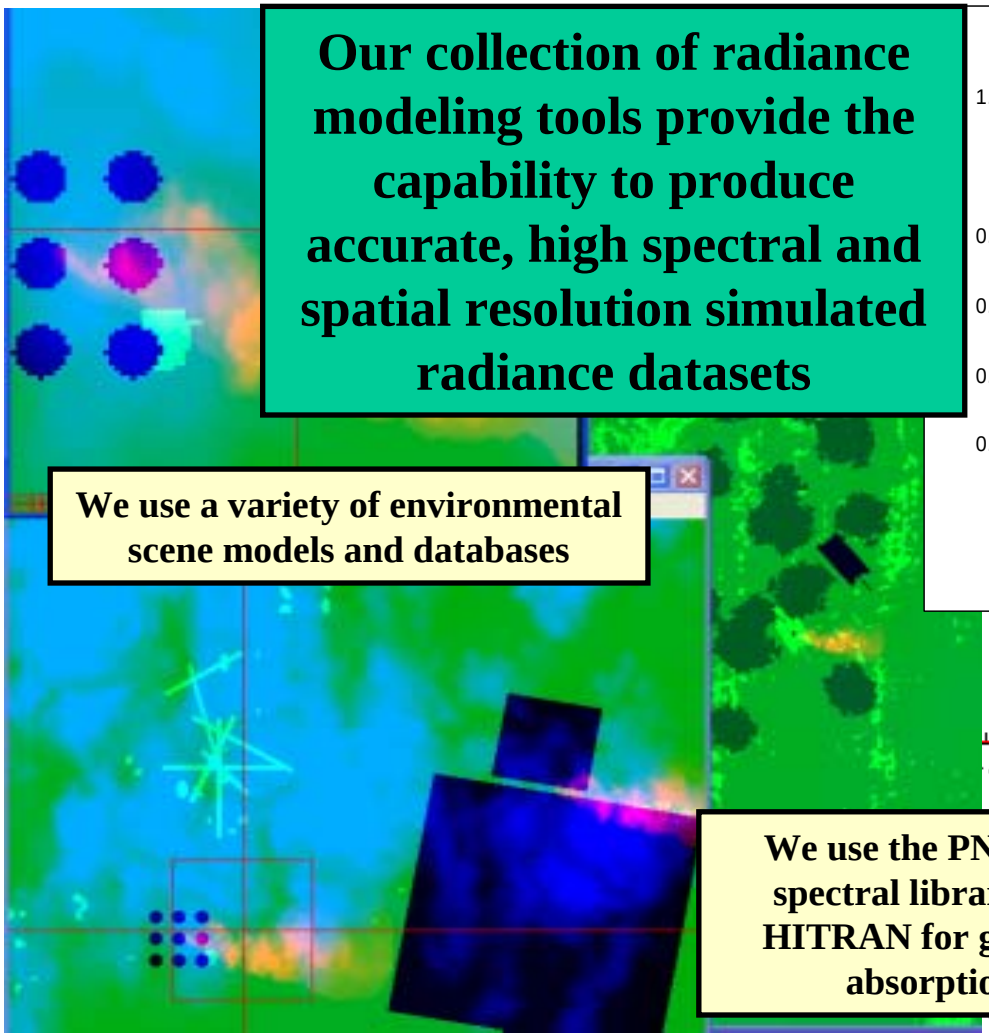
Scene Generation: Physics-based Environmental Modeling

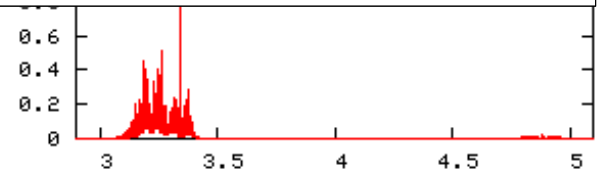
Our collection of radiance modeling tools provide the capability to produce accurate, high spectral and spatial resolution simulated radiance datasets

We use fast forward monochromatic and band models as well as line by line high spectral resolution models

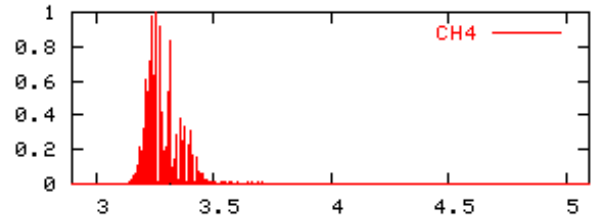


We use a variety of environmental scene models and databases



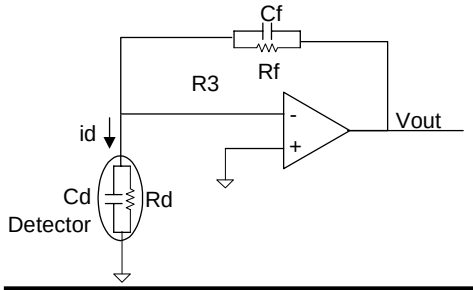


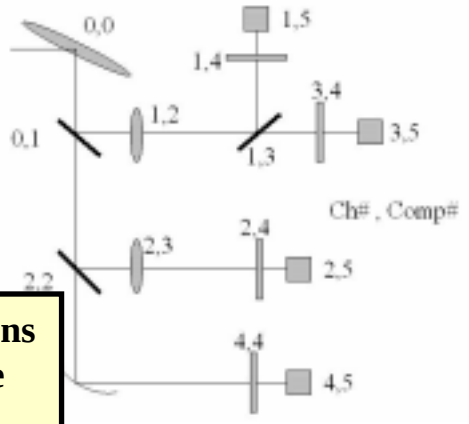
We use the PNNL IR spectral library and HITRAN for gaseous absorption



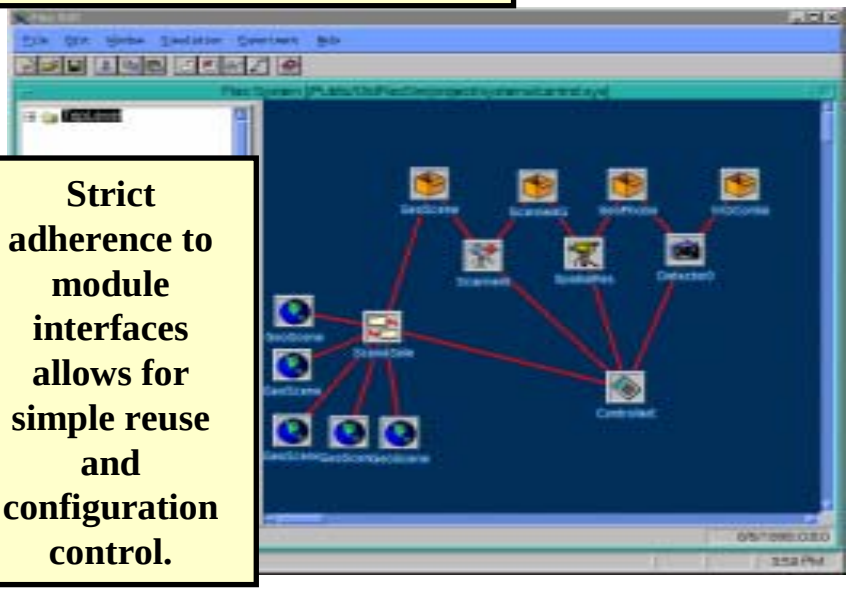
ITT Industries
Engineered for life
Advanced Engineering & Sciences

Hardware Modeling: Performance Estimation from Initial Concept to Operations



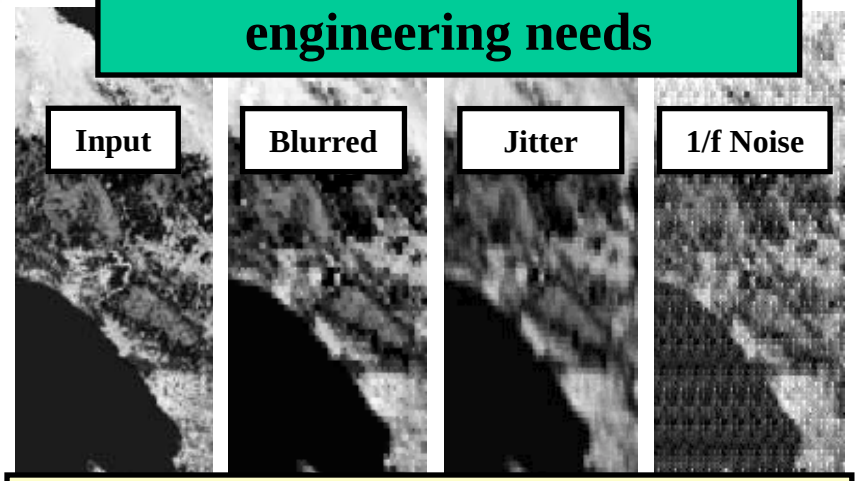


Interface to detailed descriptions of subsystem modules ensure fidelity at the system level.



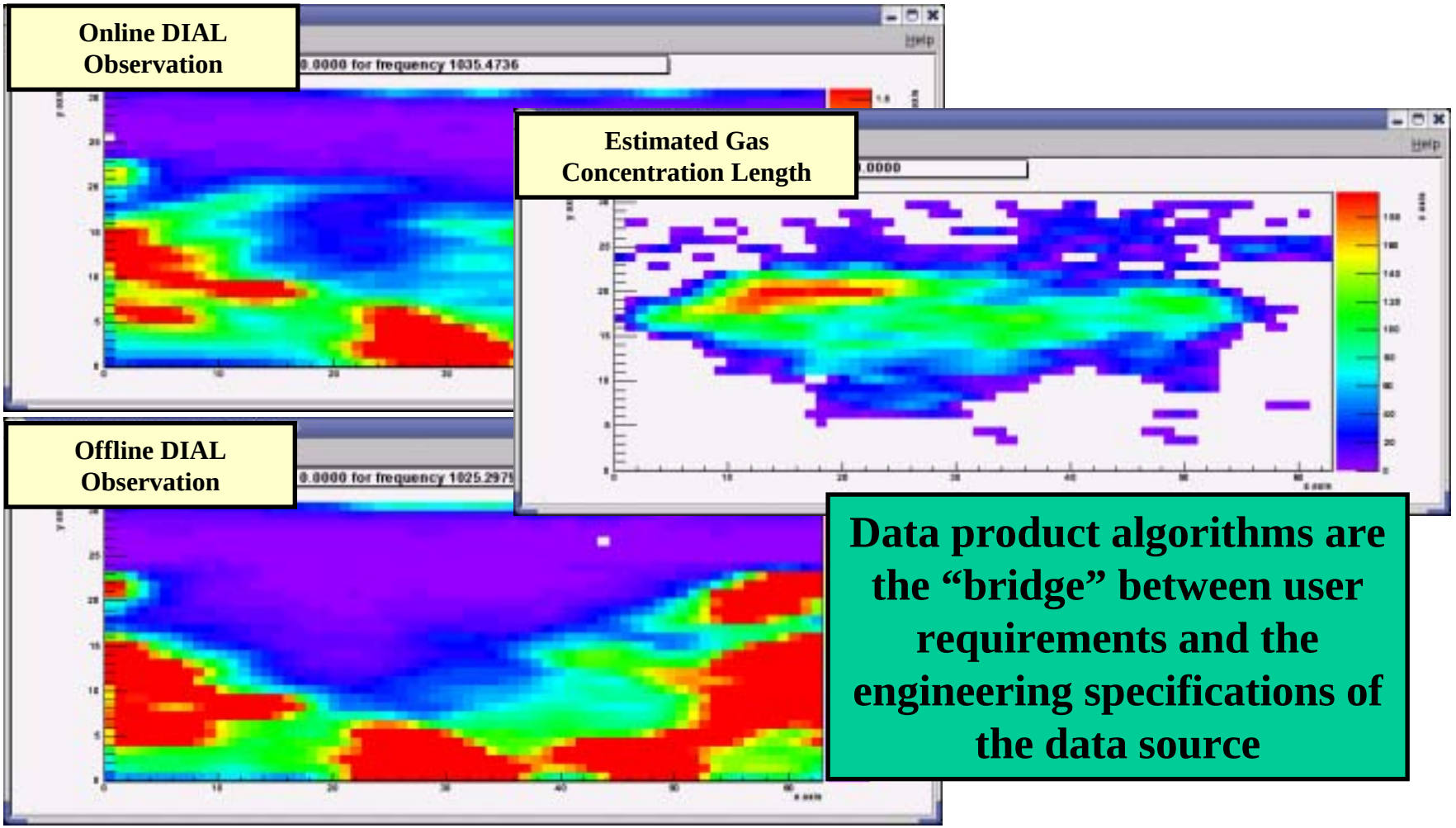
Strict adherence to module interfaces allows for simple reuse and configuration control.

Our sensor models evolve as our design matures in order to provide the most accurate representation of sensor performance needed to support changing system engineering needs



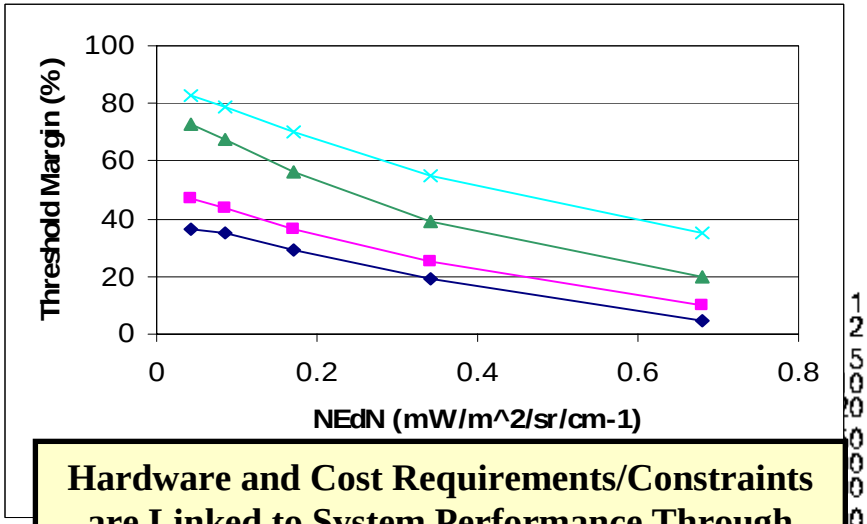
The modular design of our sensor models allow for "test points" throughout the system.

Data Exploitation: Extracting Useful Information from the Data



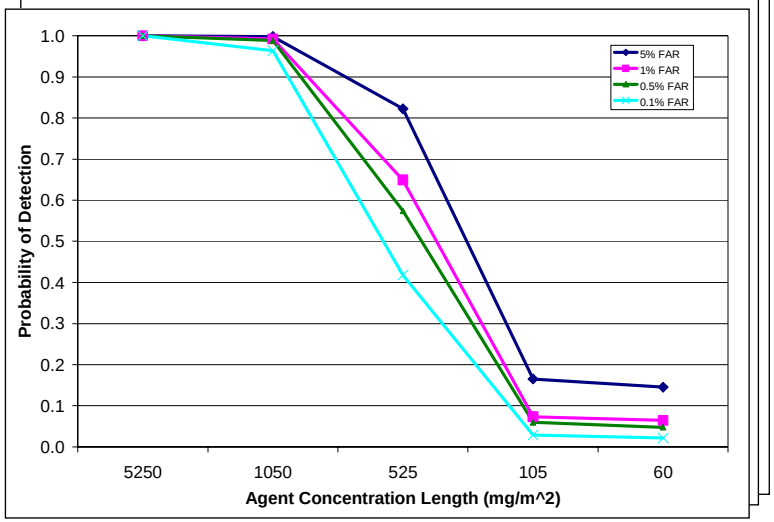
ITT Industries
Engineered for life
Advanced Engineering & Sciences

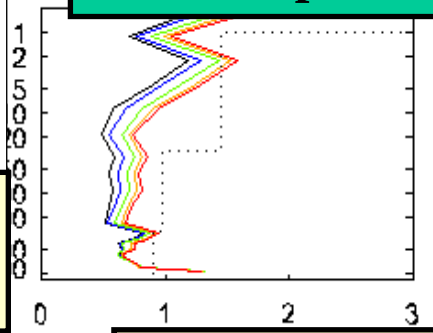
Performance Analysis and Evaluation: Closing the Loop to Lead to Improved Systems

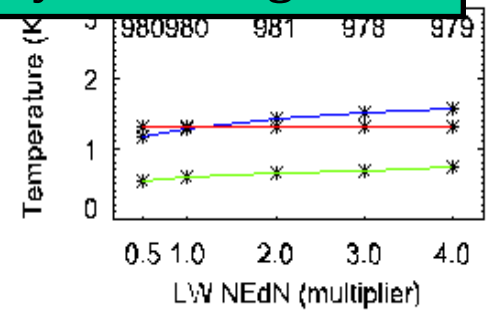


Detailed evaluation of system simulation and test results provide the information feedback necessary to optimize system design

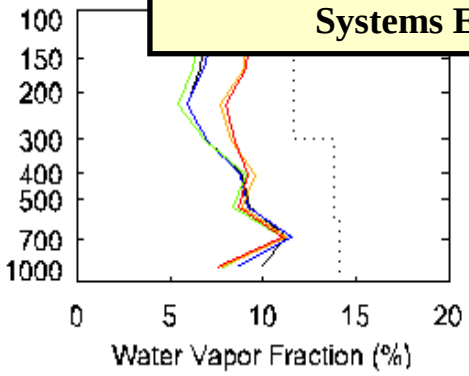
Hardware and Cost Requirements/Constraints are Linked to System Performance Through Parametric Curves.

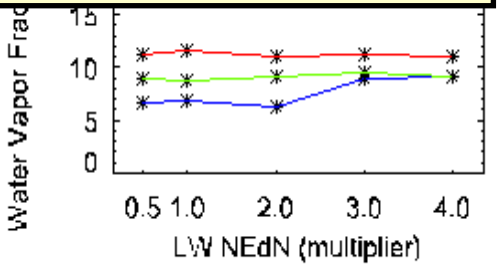






Easy to Use Tools Allow Real-Time Analysis by Systems Engineers and Analysts





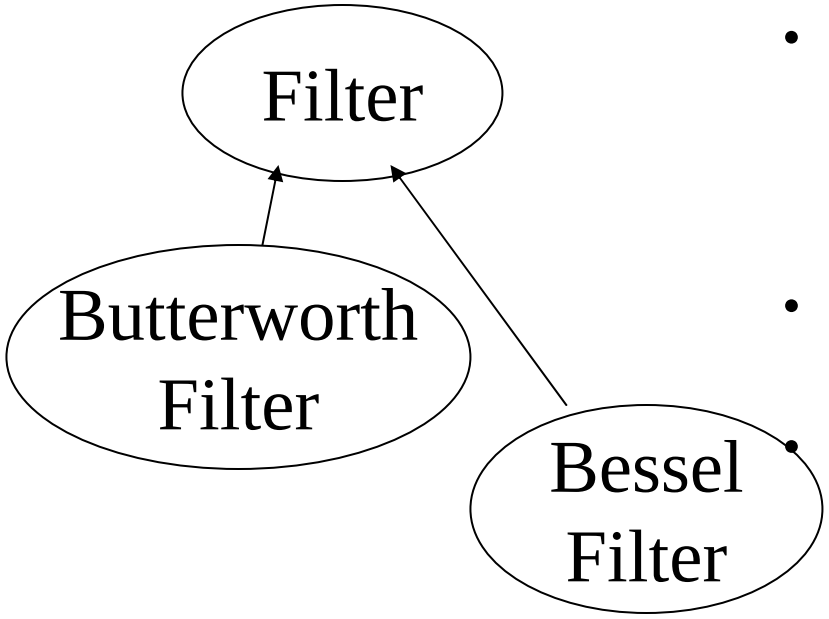
ITT Industries
Engineered for life
Advanced Engineering & Sciences

SPEED System Development Architecture is Grounded in Object-Oriented Design

- CSF, being based on C++, is intrinsically object-oriented.
- Object-oriented programming represents a different paradigm from conventional function programming.
- Object-oriented architectures are meant to do the following:
  - Mimic the way a systems engineer may draw a block diagram of a system.
  - Mimic the way the physical phenomena occur within the system.
- Object-oriented architectures encapsulate functionality. Interfaces between modules require strict definition.
- The method that a module uses to perform a task is not important; it is only important the inputs and outputs of the task be well-defined.
- An object-oriented module is called a class.

SPEED Supports Code Reuse Through its Hierarchical Architecture and Inheritance

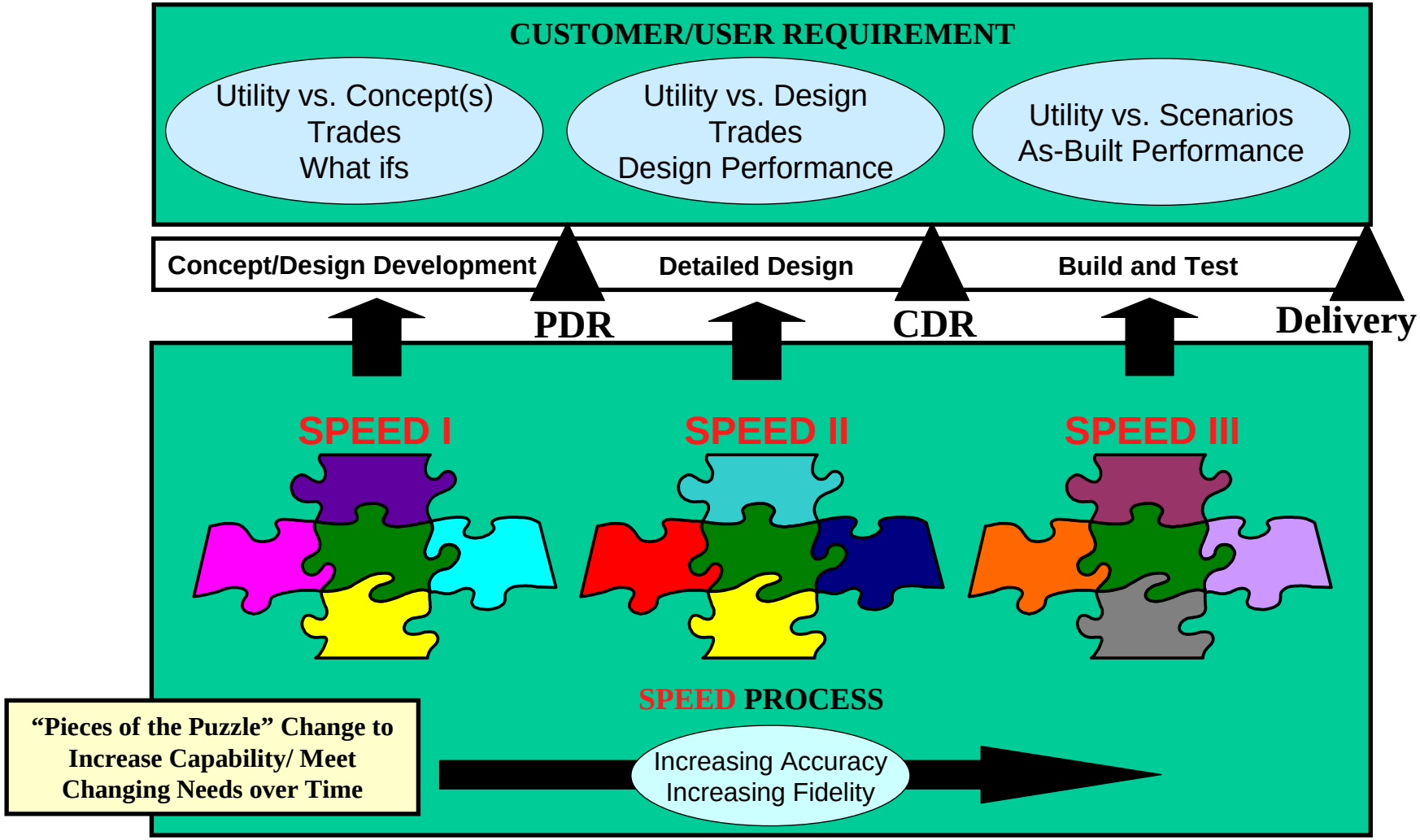
- A hierarchical architecture, in the object-oriented sense, allows one to reuse code by allowing new modules to inherit the behaviors of high level modules.



A Booch diagram for Filters

- For example, a filter has essentially the same code, no matter what type the filter is, except that the parameters may vary slightly, and the impulse response function will vary.
- A generic filter can be defined with these generic behaviors.
- A Butterworth or Bessel filter can then be made by overriding the impulse response function and adding a couple of new parameters; thus, the specialized filters inherit their general behavior from a base class.

SPEED Evolves and Matures With the Program to Best Support Program/Design Decisions

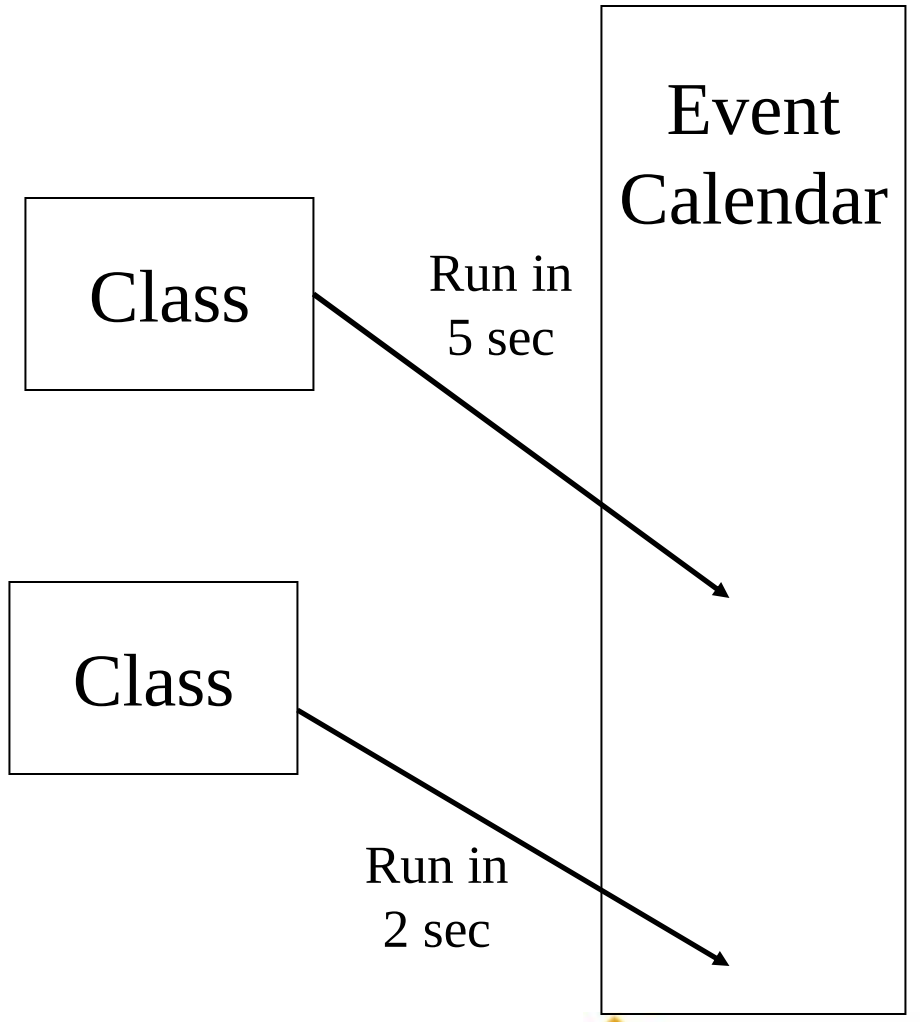


SPEED Can Integrate Multiple Execution Models Within Single Systems

- The execution model is the part of a simulation or model which dictates in what order simulation modules are run. This is an important task in object-oriented code.
- An event-based execution model allows execution of modules in order given by a global event calendar. Individual class instantiations (objects) are responsible for scheduling themselves to run at the appropriate times on the event calendar.
  - An event-based execution model is similar to that used in SPICE, where a global time variable keys each component how to respond.
- A subject-observer model uses an intermediate container class to collect data and notify other classes when the data has been updated.
  - Subject-observer architecture is similar to that supported in Khoros Cantata for digital image processing. Data flows from one process to the next.

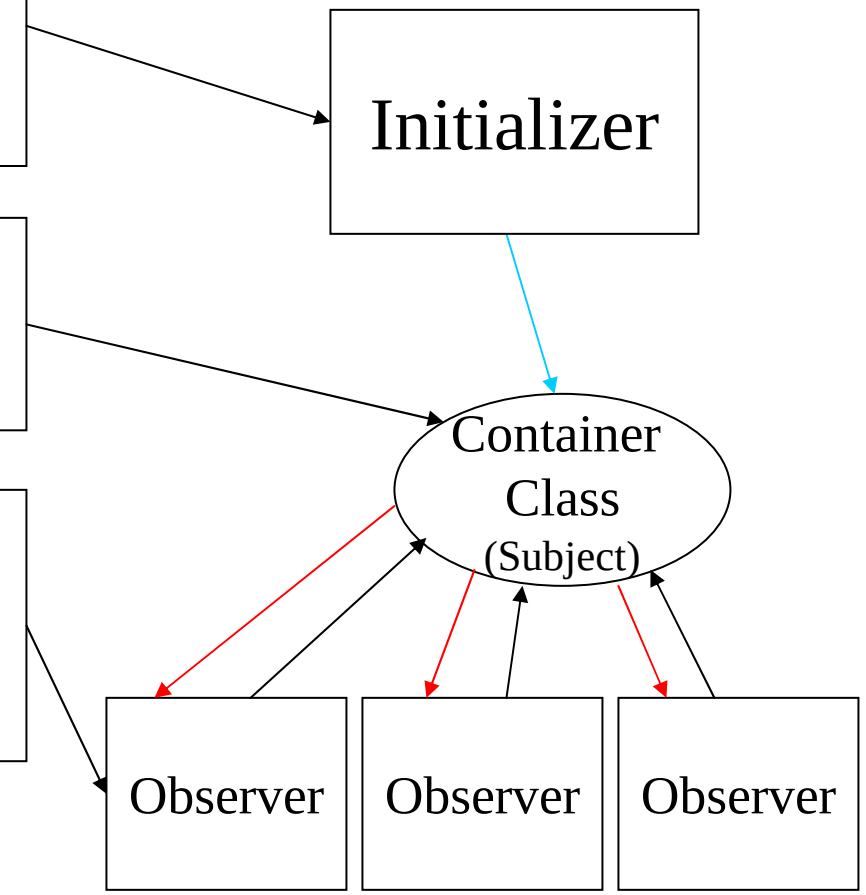
Event-based Execution is Driven By Simulation Time and Priority Scheduled on the Event Calendar

- A global event calendar is kept with all modules and when to execute them.
- A class will schedule when it needs to run on startup of the simulation.
- The class can then schedule itself to run again as needed.
- This behavior is indicative of components which have a time constant or rate of response, such as electronic components.



Subject-Observer Execution is an Implementation of a Query/Update Model

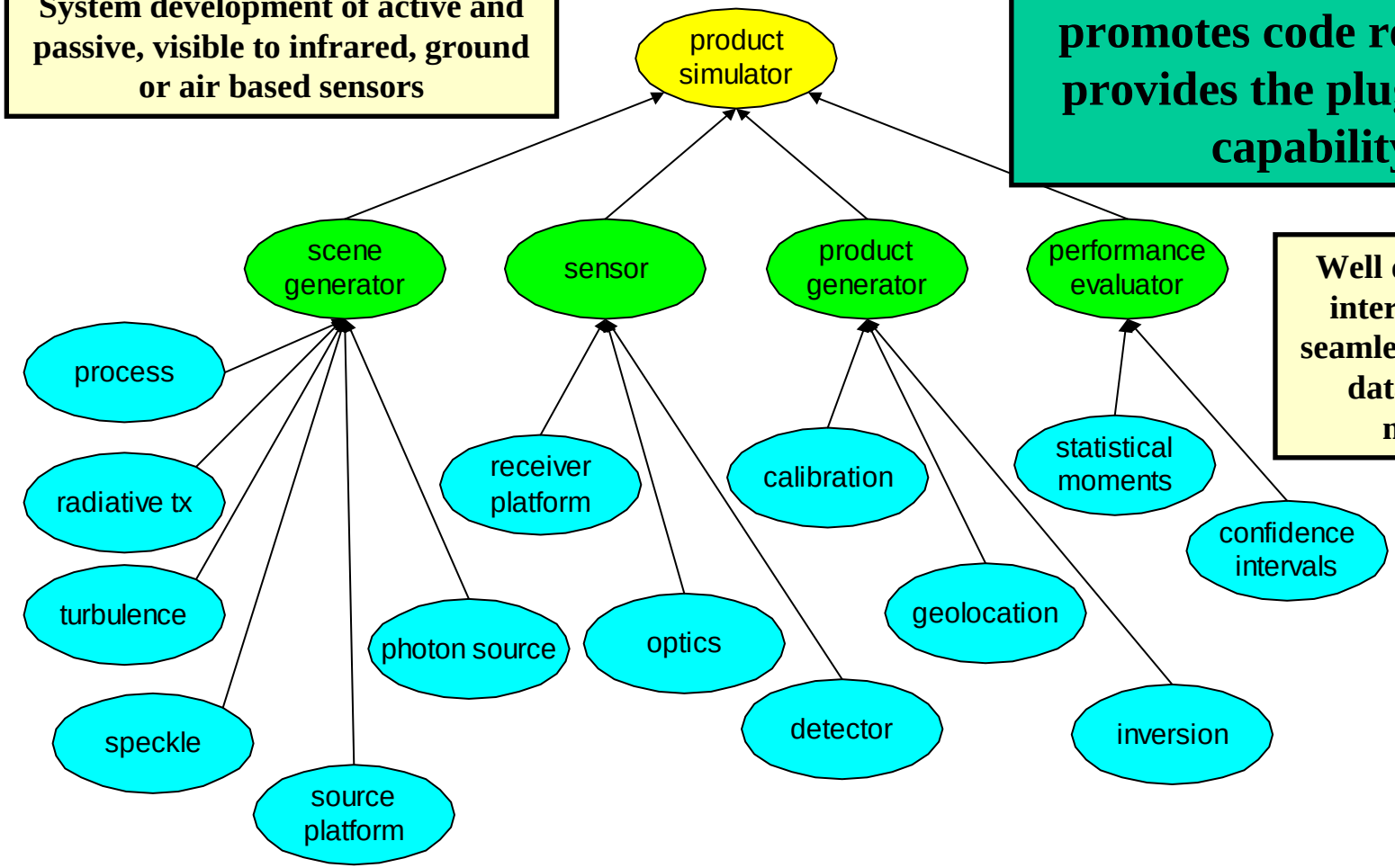
- A class which executes on start-up, an initializer, dumps output information into a container class.
- The container class then notifies all of its observers that new data is available
- The observers can then query to see if the available data is needed and request it if so desired.



CASE 2: Remote Sensing Product Simulator - A Realization of SPEED

Architecture design allows for System development of active and passive, visible to infrared, ground or air based sensors

Object-oriented design promotes code reuse and provides the plug-n-play capability

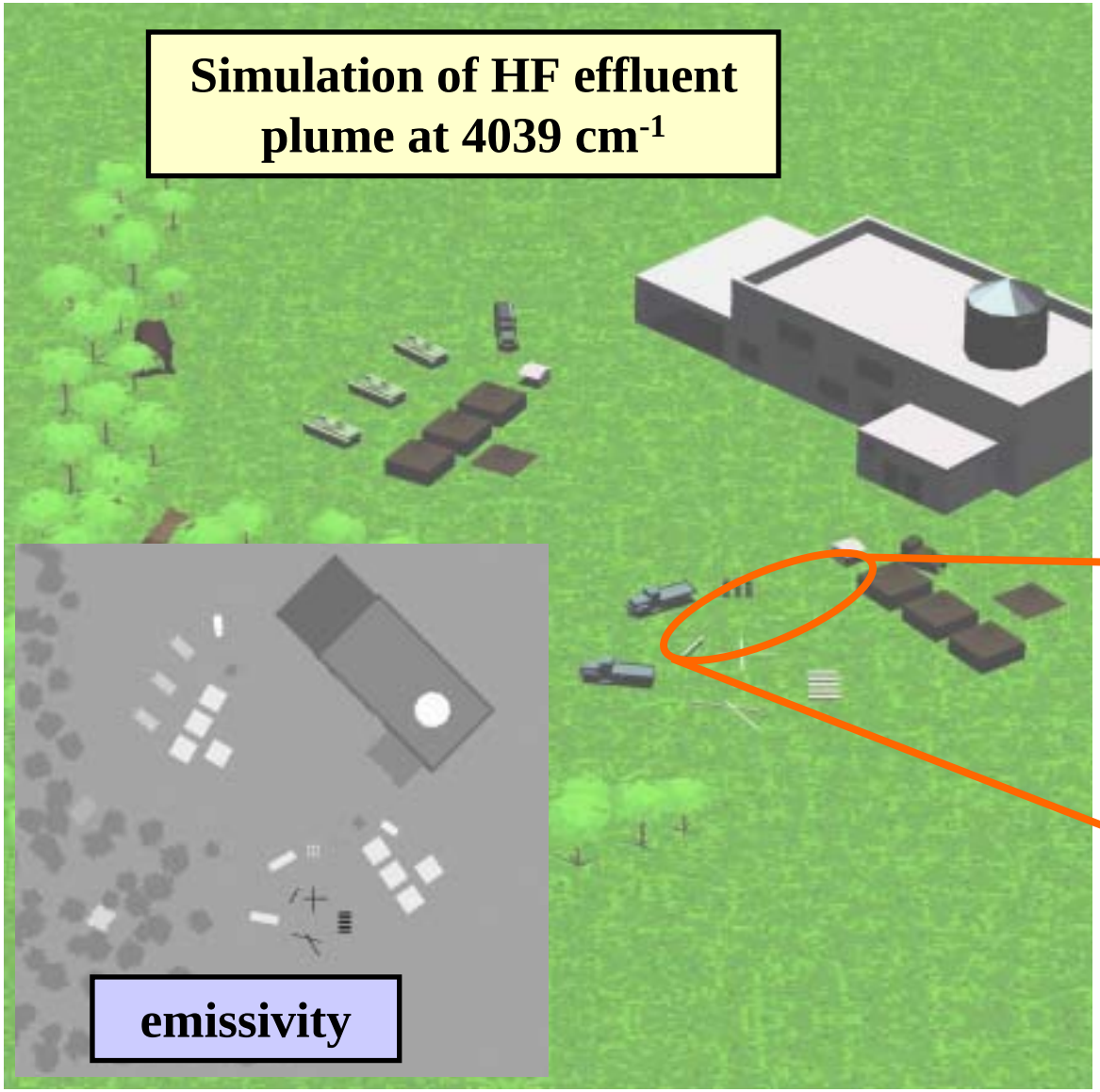


Well defined data interfaces allow seamless transfer of data between modules

ITT Industries
Engineered for life
Advanced Engineering & Sciences

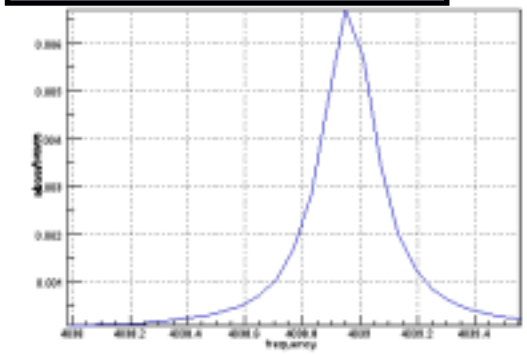
Differential Absorption LIDAR Simulation

Simulation of HF effluent plume at 4039 cm^{-1}

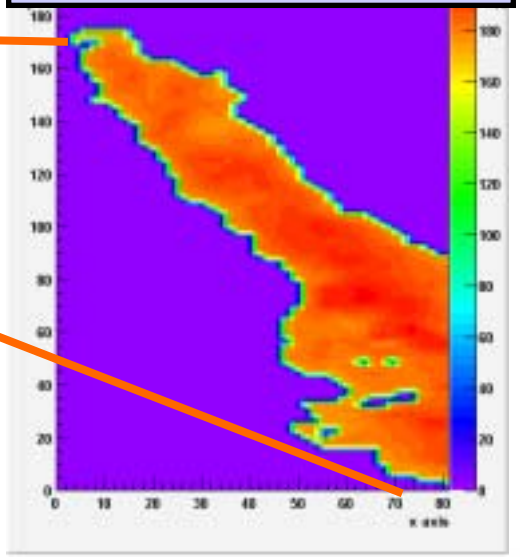


emissivity

gas absorption



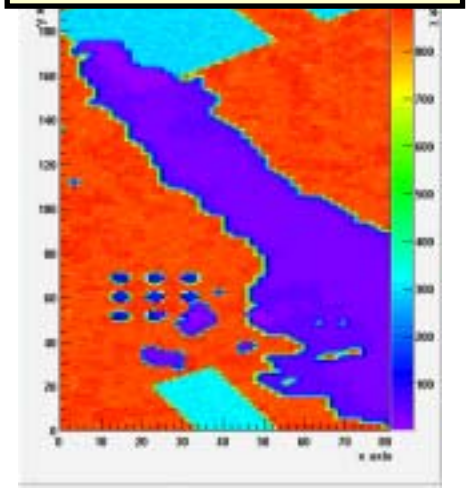
gas concen-length



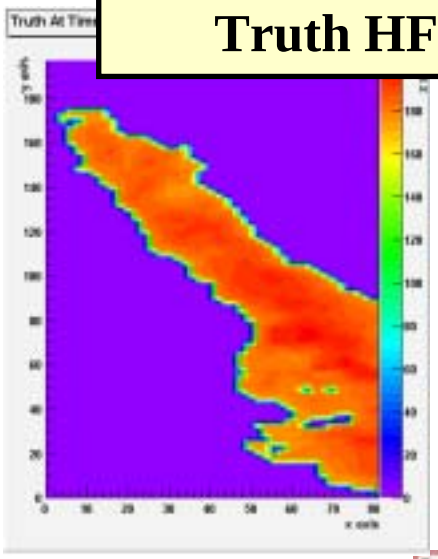
ITT Industries
Engineered for life
Advanced Engineering & Sciences

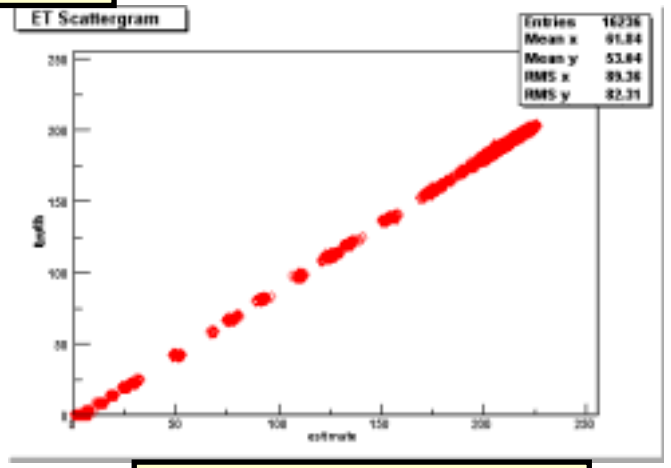
Retrieval of HF Concentration Length using DIAL

Online Return

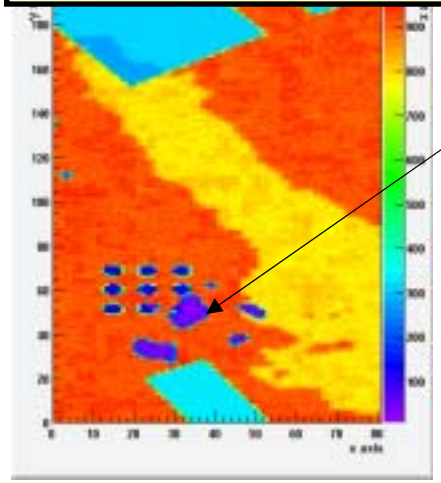


Truth HF



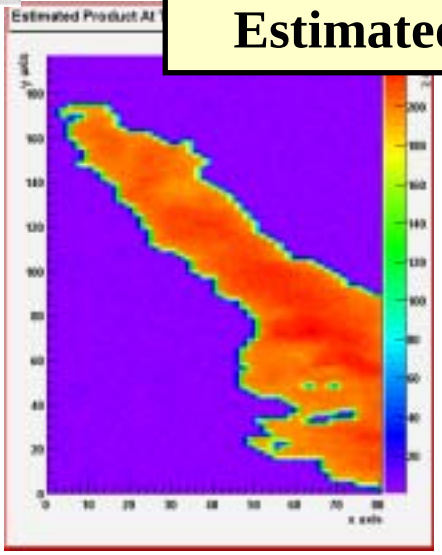


Offline Return



Water clouds

Estimated HF



ITT Industries
Engineered for life
Advanced Engineering & Sciences